MOFFAT
COLLECTION SYSTEM PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

Chapter 1:
Purpose and Need

Photo provided courtesy of Denver Water.

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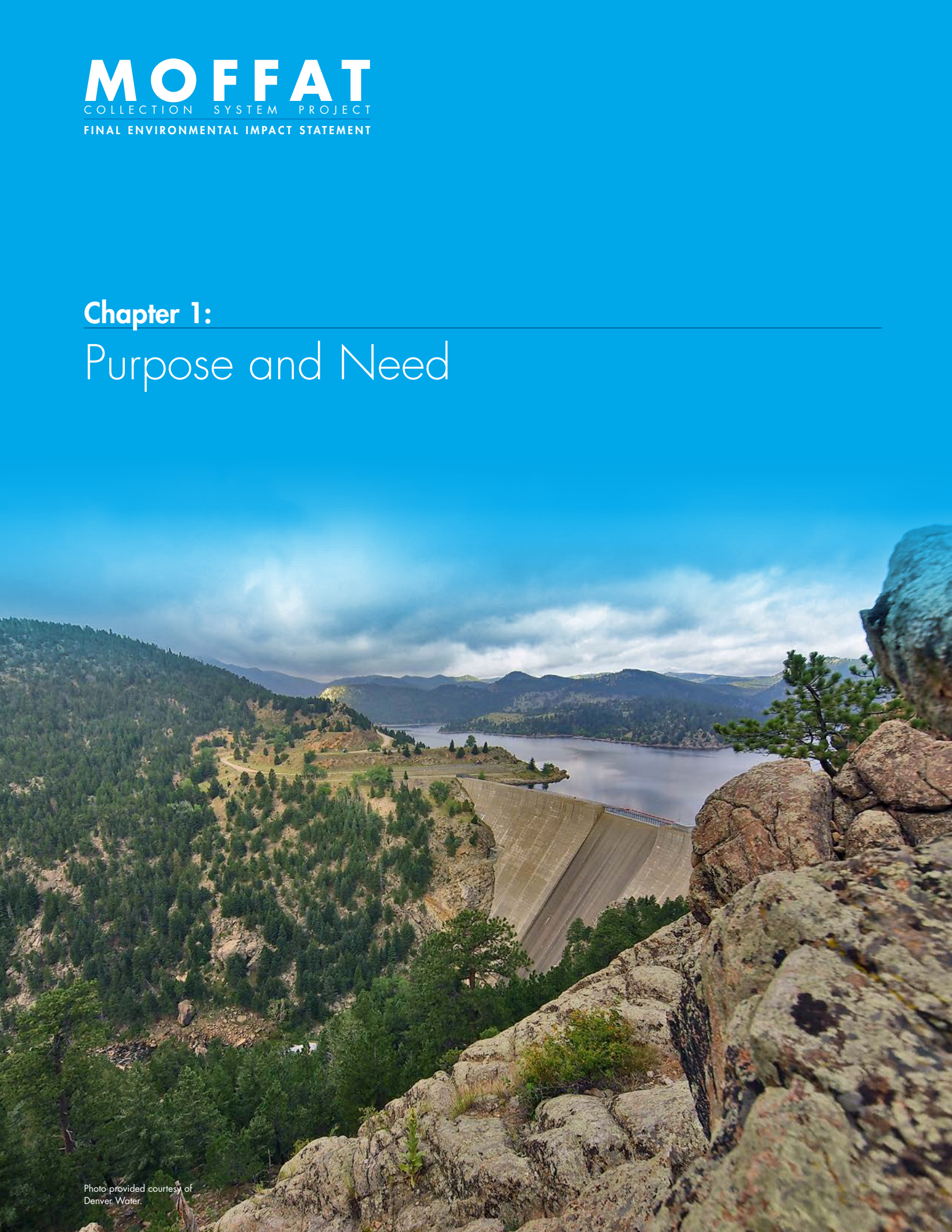

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1.0 INTRODUCTION

The United States (U.S.) Army Corps of Engineers (Corps) has prepared this Environmental Impact Statement (EIS) to analyze the direct, indirect, and cumulative effects of a water supply project called the Moffat Collection System Project (Moffat Project or Project). The Project proponent is the City and County of Denver, acting by and through its Board of Water Commissioners (Denver Water). The mission of Denver Water is to provide high quality, dependable, and safe drinking water to about 1.3 million customers in the Denver Metropolitan area.

In 2003, Denver Water notified the Corps of their intent to apply for a Department of the Army Permit (Section 404 Permit), pursuant to Section 404 of the Clean Water Act (CWA), to place fill material in jurisdictional waters of the U.S., including wetlands, and in 2009 Denver Water submitted an application. The fill would be for the construction of a water storage facility associated with developing additional water supplies. The Corps determined that an analysis of the significant natural and human environmental effects of the proposed Moffat Project and reasonable range of alternatives is necessary to provide for full public disclosure and to aid in decision-making. This EIS was prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA), and the Corps regulations for implementing NEPA (33 Code of Federal Regulations [CFR] 325, Appendix B). This EIS has also been formulated to address the information requirements of the Section 404(b)(1) Guidelines (40 CFR 230). The Corps, Omaha District, Regulatory Branch is the lead Federal agency responsible for preparing the EIS. The Corps is assisted by a team of third-party contractors led by URS Corporation, working under the direction of, and in cooperation with, the Corps in accordance with December 17, 1997 guidance from the Chief of Engineers regarding preparation of an EIS.

The Corps also requested that three Federal agencies, with statutory authority over the proposed Moffat Project, participate in the NEPA process as cooperating agencies (40 CFR 1501.6 and 1508.5), including the U.S. Environmental Protection Agency (EPA), Federal Energy Regulatory Commission (FERC), and the U.S. Forest Service (USFS). Throughout the NEPA process, FERC has focused their input on the area around Gross Reservoir to coincide with the boundary that includes the hydropower relicensing amendment (refer to Section 2.3.2.1). Formal Cooperating Agency agreements were executed between the Corps and FERC and EPA. The USFS declined to be a Cooperating Agency. After the release of the Draft EIS, the State of Colorado Department of Natural Resources and the Colorado Department of Public Health and Environment also became Cooperating Agencies to facilitate Federal and State coordination under the Fish and Wildlife Coordination Act and Section 401 of the CWA, respectively. Although the Corps denied a request by Grand County to be a Cooperating Agency, they did grant Consulting Agency status relative to effects on county resources.

1.1 PROJECT PURPOSE AND NEED STATEMENT

Denver Water's Collection System is composed of two major systems: the North System (also known as the Moffat Collection System) and the South System. These two raw water

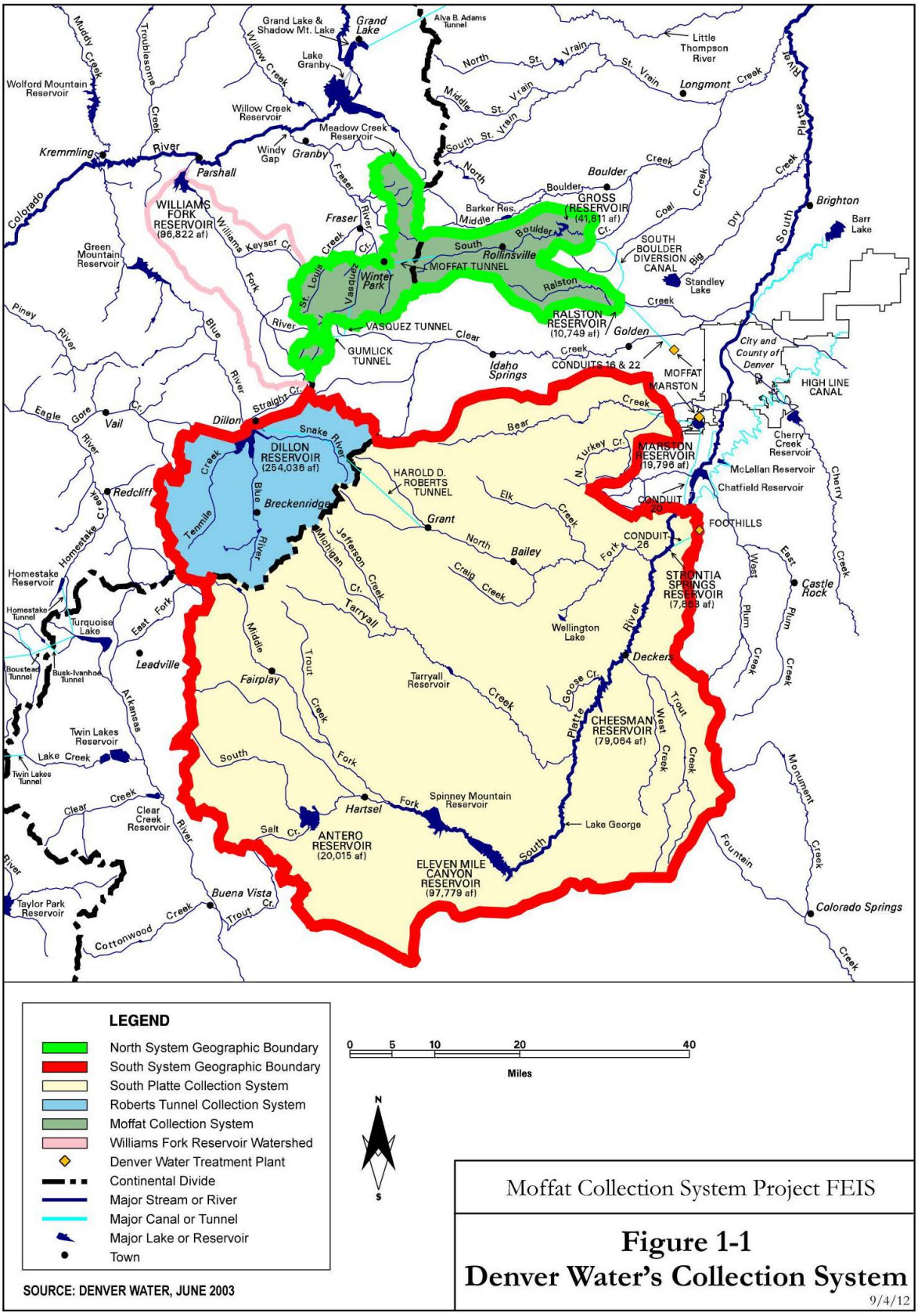
systems are geographically distinct and are not physically connected. The two collection systems are shown in Figure 1-1 and described in detail in Section 1.3.

Denver Water developed an Integrated Resources Plan (IRP) in 1997, with an update in 2002, to analyze existing and future water supplies and customer demands (Denver Water 1997, 2002a). Based on the IRP and events such as the 2002 drought and forest fires in publicly-owned watersheds that provide the majority of Denver Water's supply, Denver Water identified four needs in the Moffat Collection System that required resolution. These needs, presented to the public during the Moffat Project NEPA scoping period in 2003, are as follows:

- **The Reliability Need** – Existing water demands served by Denver Water's Moffat Collection System exceed available supplies from the Moffat Collection System during a drought, causing a water supply reliability problem. In a severe drought, even in a single severe dry year, the Moffat Water Treatment Plant (WTP)—one of three treatment plants in Denver Water's system—is at a significant level of risk of running out of water.
- **The Vulnerability Need** – Denver Water's Collection System is vulnerable to manmade and natural disasters because 90 percent (%) of available reservoir storage and 80% of available water supplies rely on the unimpeded operation of Strontia Springs Reservoir and other components of Denver's Water's South System.
- **The Flexibility Need** – Denver Water's treated water transmission, distribution, and water collection systems are subject to failures and outages caused by routine maintenance, pipe failures, treatment plant problems, and a host of other unpredictable occurrences that are inherent in operating and maintaining a large municipal water supply system. These stresses to Denver Water's ability to meet its customers' water supply demands require a level of flexibility within system operations that is not presently available.
- **The Firm Yield Need** – Denver Water's near-term (prior to 2032) water resource strategy and water service obligations, which have occurred since the IRP was developed, have resulted in a need for 18,000 acre-feet per year (AF/yr) of new near-term firm yield. This need was identified after first assuming successful implementation of a conservation program, construction of a non-potable recycling project, and implementation of a system refinement program.

During the NEPA scoping process, Denver Water did not select a specific project to address these needs, but rather explored various alternatives through the NEPA alternatives screening process, which led to the selection of their preferred alternative. Refer to Section 1.2 for further details on Denver Water's preferred alternative.

Based on comments received during NEPA scoping and guidance from the Corps, Denver Water developed their Purpose and Need statement, and prepared a document to substantiate the statement and provide background information on their water supply system. The draft document was reviewed by the Corps, EPA, FERC, and USFS. The final document was published in 2004 as Purpose and Need Statement for the Moffat Collection System Project (Denver Water 2004a).


Grand Lake & Shadow Mt. Lake
Grand Lake
Alva B. Adams Tunnel
Little Thompson River
Lake Granby
North St. Vrain
St. Vrain
Longmont
Wolford Mountain Reservoir
Willow Creek Reservoir
Middle St. Vrain
Meadow Creek Reservoir
Windy Gap
Granby
South St. Vrain
Kremmling
Parshall
Boulder
GROSS RESERVOIR (41,811 af)
Brighton
WILLIAMS FORK RESERVOIR (96,822 af)
Barker Res.
Middle Boulder Cr.
Barr Lake
Green Mountain Reservoir
Fraser River
South Boulder Creek
SOUTH BOULDER DIVERSION CANAL
Rollinsville
MOFFAT TUNNEL
Winter Park
Standley Lake
Ralston Creek
RALSTON RESERVOIR (10,749 af)
VASQUEZ TUNNEL
GUMLICK TUNNEL
Golden
City and County of Denver
Idaho Springs
CONDUITS 16 & 22
MOFFAT
MARSTON
HIGH LINE CANAL
Dillon
Vail
Straight Cr.
Bear Creek
DILLON RESERVOIR (254,036 af)
Snake River
MARSTON RESERVOIR (19,796 af)
Cherry Creek Reservoir
McLellan Reservoir
Chatfield Reservoir
Redcliff
HAROLD D. ROBERTS TUNNEL
Breckenridge
Grant
CONDUIT 20
FOOTHILLS
CONDUIT 26
Bailey
STRONTIA SPRINGS RESERVOIR (7,883 af)
Castle Rock
Homestake Reservoir
Homestake Tunnel
Turquoise Lake
Leadville
Wellington Lake
Deckers
Fairplay
Tarryall Reservoir
Boustead Tunnel
Busk-Ivanhoe Tunnel
Twin Lakes Reservoir
Lake Creek
Twin Lakes Tunnel
CHEESMAN RESERVOIR (79,064 af)
Spinney Mountain Reservoir
Hartsel
Lake George
Clear Creek Reservoir
ANTERO RESERVOIR (20,015 af)
ELEVEN MILE CANYON RESERVOIR (97,779 af)
Taylor Park Reservoir
Buena Vista
Colorado Springs
Cottonwood Creek
LEGEND
North System Geographic Boundary
South System Geographic Boundary
South Platte Collection System
Roberts Tunnel Collection System
Moffat Collection System
Williams Fork Reservoir Watershed
Denver Water Treatment Plant
Continental Divide
Major Stream or River
Major Canal or Tunnel
Major Lake or Reservoir
Town
0 5 10 20 40
Miles
N
S
SOURCE: DENVER WATER, JUNE 2003
Moffat Collection System Project FEIS
Figure 1-1
Denver Water's Collection System
9/4/12

The Corps, exercising its independent judgment while considering both Denver Water's and the public's perspectives (33 CFR 325, Appendix B.9[b][4]), evaluated and accepted the Purpose and Need statement as the basis for defining and evaluating alternatives within the Corps' decision-making process (Corps 2004).

Purpose and Need Statement

> *The purpose of the Moffat Collection System Project is to develop 18,000 acre-feet per year of new, firm yield to the Moffat Treatment Plant and raw water customers upstream of the Moffat Treatment Plant pursuant to the Board of Water Commissioners' commitment to its customers*.

Denver Water's need for the proposed Moffat Project is based on two major issues, one of timeliness and one of location:

1. Timeliness: Water Supply Shortage in the Near-Term Timeframe (Prior to 2032) – Beginning as early as 2022, Denver Water predicts its average annual water demand could exceed available supplies and grow to 34,000 AF/yr by 2032. This shortfall was determined after analyzing existing supply, projected demand, and savings from system refinements, non-potable reuse, natural replacement, and cooperative projects with other water providers. Of this near-term 34,000 AF/yr shortfall, Denver Water will rely on 16,000 AF/yr forthcoming from the implementation of additional conservation efforts. New firm yield must be identified to meet the remaining shortfall. Denver Water proposes to meet the remaining shortfall with 18,000 AF/yr of newly developed supplies.

2. Location: Need for Water to the Moffat Water Treatment Plant and Raw Water Customers – Approximately 90% of the available reservoir storage and 80% of the available water supplies rely on the South System. This imbalance in reservoir storage and water supplies between the North and South systems has created water supply challenges that have resulted in:

- Unreliable water supply for the Moffat WTP and Moffat Collection System raw water customers
- System-wide vulnerability issues
- Limited operational flexibility of the treated water system

Section 1.4.4 provides further discussion on the availability of water to the Moffat WTP, and system-wide vulnerability and flexibility issues.

To address the two major issues, Denver Water is pursuing the proposed Moffat Project to provide 18,000 AF/yr of new firm yield to the Moffat WTP. The proposed Project would address both the overall near-term water supply shortage, and the imbalance in water storage and supply between the North and South systems.

1.2 DENVER WATER'S PREFERRED ALTERNATIVE

Denver Water's preferred alternative is to enlarge its existing 41,811-acre-foot (AF) Gross Dam and Reservoir, which is located in Boulder County, Colorado approximately 35 miles

northwest of Denver and 6 miles southwest of the City of Boulder. The proposed Moffat Project is to expand the existing reservoir by 72,000 AF to a total storage capacity of 113,811 AF. This would be accomplished by raising the existing concrete gravity arch dam by 125 feet, from 340 to 465 feet high. The surface area of the reservoir would be expanded from approximately 418 to 818 acres, which would inundate approximately 400 acres of surrounding shoreline.

In addition, for environmental mitigation purposes, Denver Water is proposing to raise the dam an additional 6 feet, for to a total dam height of 471 feet, in order to seasonally store an additional 5,000 AF of water in Gross Reservoir for use in environmental flow releases. This additional storage, which is identified in this document as the "Environmental Pool," would further increase total storage in the reservoir to 118,811 AF, and would increase the surface area to 842 acres. Storage of the Environmental Pool would increase shoreline inundation by approximately 24 acres. The additional storage would be filled with water provided by the cities of Boulder and Lafayette.

Using existing collection infrastructure, water from the Fraser River, Williams Fork River, and South Boulder Creek would be diverted and delivered during average to wet years via the Moffat Tunnel and South Boulder Creek to Gross Reservoir. In order to firm this water supply and provide 18,000 AF/yr of new firm yield, an additional 72,000 AF of storage capacity is necessary. Existing facilities, including the South Boulder Diversion Canal, Ralston Reservoir and Conduits 16 and 22, would be used to deliver water from the enlarged Gross Reservoir to the Moffat WTP and raw water customers. To meet future demands, in most years, Denver Water would continue to rely on supplies from the North and South collection systems. In a drought or emergency, Denver Water would rely on the additional water it would have previously stored in the Moffat Collection System to provide the additional 18,000 AF of yield. Chapter 2 (Section 2.3) provides a detailed description of the Proposed Action (Denver Water's preferred alternative).

1.3 DENVER WATER'S EXISTING SYSTEM

Denver Water's system is comprised of a water collection system, which stores and distributes raw water prior to treatment, and a treated water system, which delivers treated water to the customers. The following is a general description of Denver Water's system, which is based upon documents provided by Denver Water (Denver Water 2002a, 2003a, 2004a).

1.3.1 Raw Water Collection System

The water collection system is defined as all facilities that divert, collect, store, and distribute water prior to treatment. Denver Water's raw water collection system is comprised of two major delivery systems, which are not physically connected. Refer to Figure 1-1.

- The North System (Moffat Collection System) is comprised of the Moffat Tunnel Collection System and delivers water to the Moffat WTP.
- The South System, which is comprised of the Roberts Tunnel Collection System (including Dillon Reservoir) and the South Platte Collection System, delivers water to Foothills and Marston WTPs.

Other components of Denver Water's Collection System that are relevant to this EIS include replacement facilities, exchange source, the non-potable recycling facility, and hydropower generation at Gross Reservoir.

1.3.1.1 North System Overview

The Moffat Tunnel Collection System captures water from the Williams Fork River, Fraser River, South Boulder Creek, and Ralston Creek, and subsequently delivers this water to the Moffat WTP and several raw water customers upstream of the plant. The major facilities in this system include the Williams Fork River Collection System, Gumlick Tunnel, Vasquez Tunnel, the Fraser River Collection System, the Cabin-Meadow Creek Collection System, Moffat Tunnel, Gross Reservoir, South Boulder Diversion Canal, and Ralston Reservoir. Figure 1-2 displays these major facilities in the North System. It is important to understand the flow of water within the Moffat Collection System to be able to understand and evaluate the alternatives' potential effects, discussed subsequently in the EIS. The following text provides general information on the facilities and traces water as it is collected in the upper reaches of the collection system down to the Moffat WTP.

The Williams Fork Collection System collects and conveys water from high elevation tributaries of the Williams Fork River to the Gumlick Tunnel. The Gumlick Tunnel is 2.9-miles long and carries water under the Continental Divide (Jones Pass) to the Vasquez Tunnel, which is a 3.4-mile tunnel that passes back through the Continental Divide and conveys water to Vasquez Creek. Water in Vasquez Creek, as well as water diverted from the Fraser River and tributaries, and the Cabin-Meadow Creek Diversion System, are collected and conveyed in a series of pipes, tunnels, siphons, and canals as part of the Fraser River Diversion System. The water is diverted into the 6.1-mile long Moffat Tunnel, which conveys water from the Fraser River Collection System and the Williams Fork River Collection System under the Continental Divide into South Boulder Creek, and eventually to Gross Reservoir. Gross Reservoir is located on South Boulder Creek with a gravity arch-concrete dam approximately 340 feet high and a storage capacity of 41,811 AF. Water from the reservoir is released into South Boulder Creek and is diverted through the South Boulder Diversion Structure to Ralston Reservoir. The South Boulder Diversion Structure is a gravity concrete dam 22 feet high and conduit approximately 10 miles in length. Ralston Reservoir is located on Ralston Creek with an earth-fill dam 180 feet high and a storage capacity of 10,749 AF. Water is delivered from this reservoir to the Moffat WTP via Conduits 16 and 22.

1.3.1.2 South System Overview

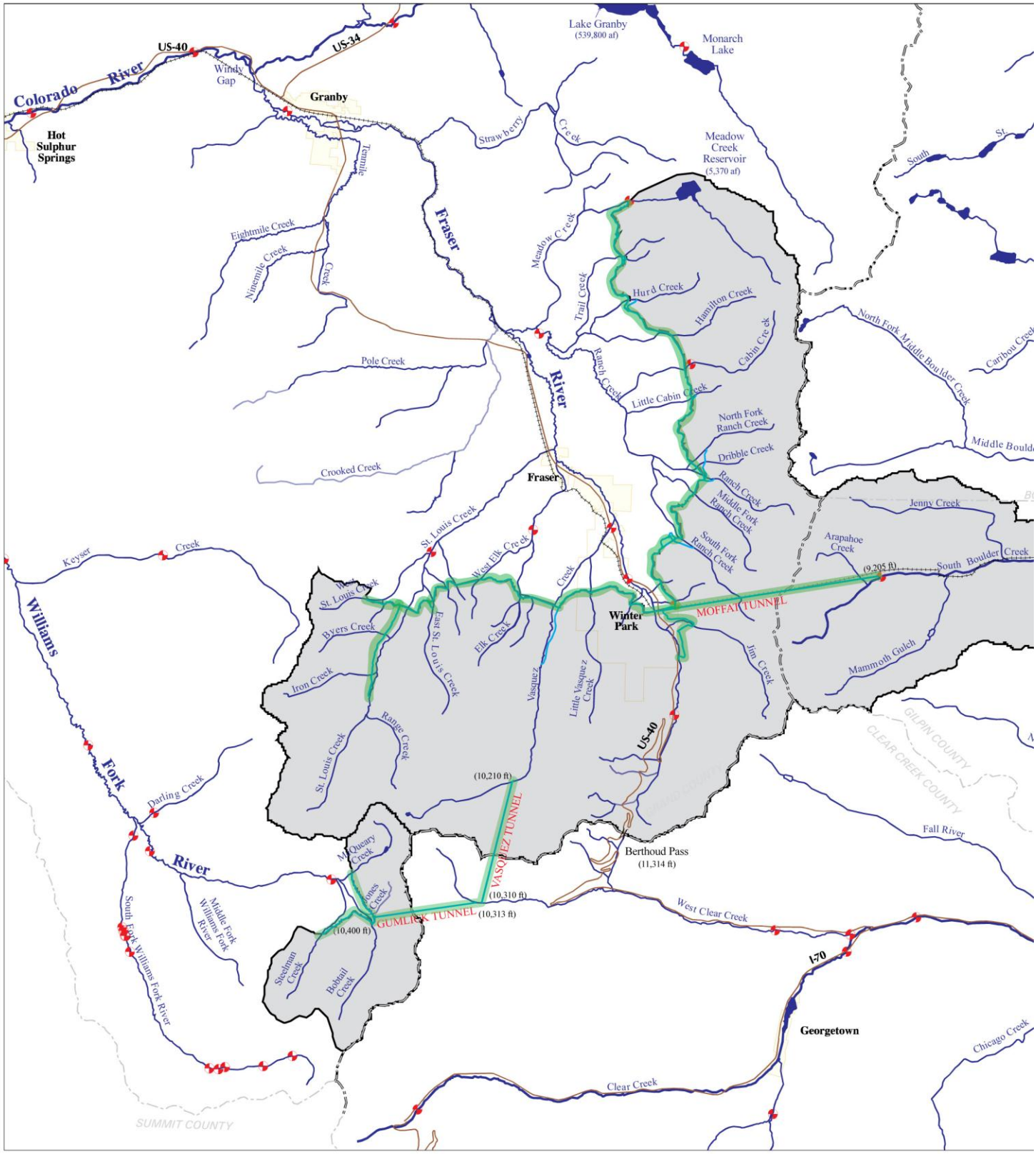
The South System is comprised of two collection systems; the Roberts Tunnel and the South Platte collection systems (Figure 1-1). The Roberts Tunnel Collection System is comprised of Dillon Reservoir and the Roberts Tunnel. Major facilities in the South Platte Collection System include Antero, Eleven Mile Canyon, Cheesman and Strontia Springs reservoirs, Conduit No. 26, Platte Canyon Intake Dam and Conduit No. 20, Marston and Platte Canyon reservoirs, and the Foothills and Marston WTPs. Denver Water also owns and operates several other facilities that are considered part of the South System, including Harriman Ditch and Conduit No. 15, Cherry Creek Wells, and other ditch systems, which are not related to the system's function as it relates to the proposed Project. The following

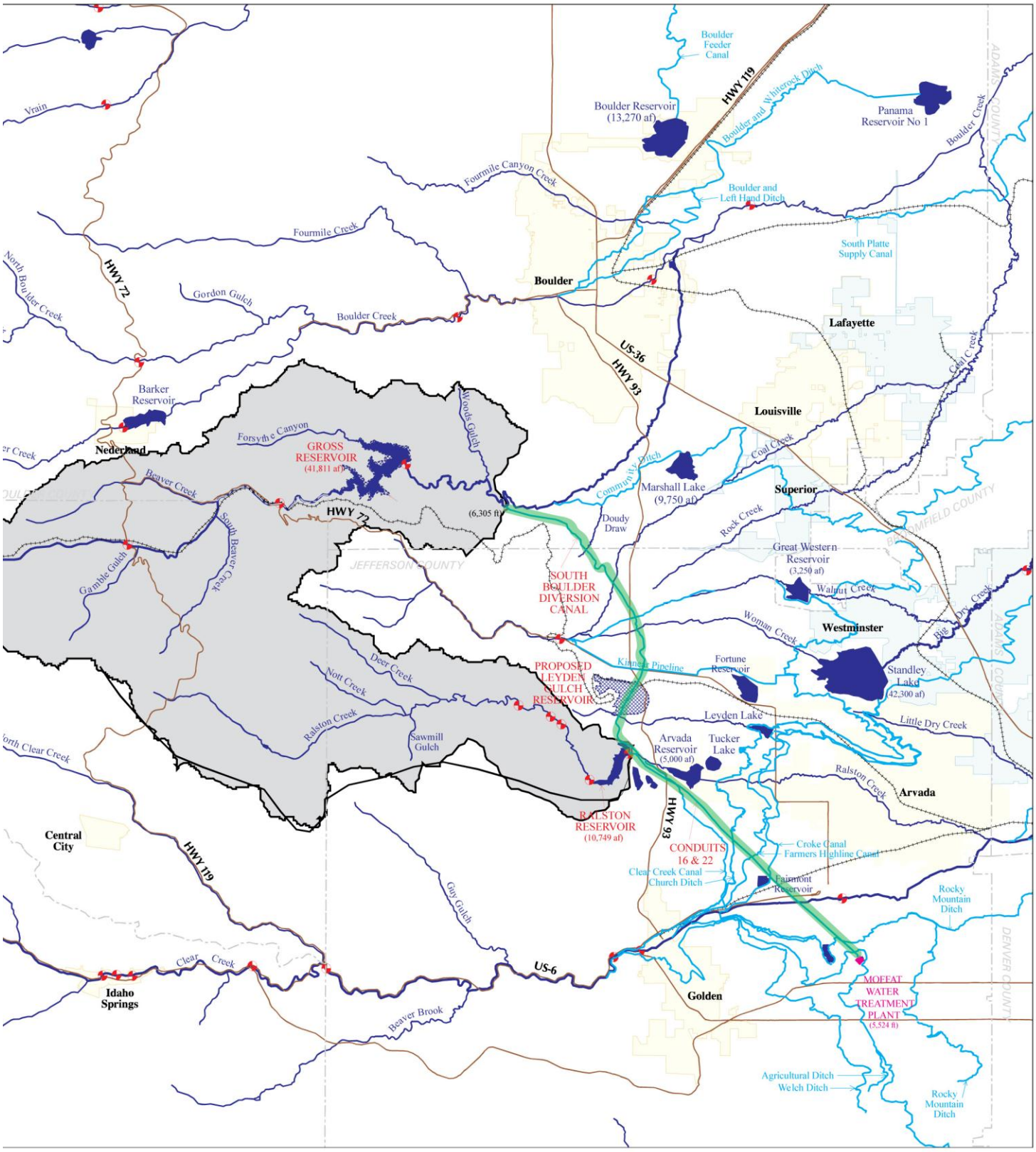
discussion below provides a brief explanation of these facilities, and traces the general flow of water in the collection system. The Roberts Tunnel Collection System includes Dillon Reservoir, which is located near the town of Dillon, Colorado at the confluence of the Blue and Snake rivers and Ten Mile Creek. The reservoir has a storage capacity of 254,036 AF with an earth-fill dam 231 feet high. The reservoir stores water from the Blue River and diverts into the Roberts Tunnel. The tunnel is 23.3 miles long and conveys water under the Continental Divide into the North Fork South Platte River, which is eventually captured by Denver Water's South Platte Collection System.

The South Platte Collection System captures water from the mainstem of the South Platte River and Bear Creek. The major facilities in the system include three storage reservoirs along the South Platte River: Antero Reservoir (20,015 AF), Eleven Mile Canyon Reservoir (97,779 AF), and Cheesman Reservoir (79,064 AF), which supply water to Strontia Springs Reservoir (7,863 AF). Water from Strontia Springs Reservoir can be delivered directly to Foothills WTP via Conduit 26, or released to the South Platte River where it can, if necessary, be diverted by Denver Water at Conduit 20, High Line Canal, or the Last Chance Ditch before reaching Chatfield Reservoir (27,428 AF). Conduit 20 is used to deliver water from the South Platte River to Marston Reservoir (19,796 AF), which serves as a storage reservoir for the Marston WTP. The High Line Canal is operated by Denver Water and delivers water to Platte Canyon Reservoir (905 AF), as well as several customers in the Denver Metropolitan area. Water diverted at the Last Chance Ditch can be delivered to Conduit 20 for delivery to Marston Reservoir or Platte Canyon Reservoir. Water stored in Platte Canyon Reservoir can be released to the South Platte River for exchanges, or to Conduit 20 for delivery to Marston Reservoir. Water diverted from Bear Creek is transferred to Marston Reservoir by Conduit 15. Denver Water also has storage rights in Chatfield Reservoir primarily to manage exchanges to Cheesman Reservoir. Chatfield Reservoir is located in Littleton and is owned and operated by the Corps primarily for flood control purposes.

1.3.1.3 Replacement Facilities

The Williams Fork Reservoir is owned and operated by Denver Water as a replacement facility for Denver Water's transmountain diversion projects. It is located on the Williams Fork River near its confluence with the Colorado River in Parshall, Colorado. The reservoir has a storage capacity of 96,822 AF with a thin arch-concrete dam 217 feet high. The reservoir provides exchange water to meet downstream senior water rights requirements, replacing water diverted from the Fraser and Williams Fork collection systems and the Roberts Tunnel Collection System. This is an example of an exchange commonly performed within the collection system, whereby out-of-priority diversions can be made in exchange for water released from Williams Fork Reservoir. Releases from Williams Fork Reservoir can also be made in substitution for releases from Green Mountain Reservoir. (In a substitution, water is released from one location in exchange for release of water at another location.) This operation allows Denver Water to fill Dillon Reservoir, which is located upstream of Green Mountain Reservoir and has junior water rights to Green Mountain, with water that Green Mountain was entitled to store. If Green Mountain Reservoir fails to fill, water supplies from the Williams Fork Reservoir are released (substituted) to downstream water demands in place of releases from Green Mountain Reservoir.


Lake Granby
(539,800 af)
Monarch Lake
Meadow Creek Reservoir
(5,370 af)
US-40
US-34
Colorado River
Windy Gap
Granby
Hot Sulphur Springs
Strawberry Creek
Tenmile Creek
Eightmile Creek
Ninemile Creek
Fraser River
Meadow Creek
Trail Creek
Hurd Creek
Hamilton Creek
Cabin Creek
Ranch Creek
Little Cabin Creek
North Fork Ranch Creek
Dribble Creek
Middle Fork Ranch Creek
South Fork Ranch Creek
Pole Creek
Crooked Creek
Fraser
St. Louis Creek
West Elk Creek
Keyser Creek
Williams Fork River
Byers Creek
Iron Creek
East St. Louis Creek
Elk Creek
Vasquez Creek
Little Vasquez Creek
Range Creek
St. Louis Creek
Winter Park
MOFFAT TUNNEL
(9,205 ft)
Jenny Creek
Arapahoe Creek
South Boulder Creek
Jim Creek
Mammoth Gulch
North Fork Middle Boulder Creek
Caribou Creek
Middle Boulder Creek
South St.
US-40
(10,210 ft)
VASQUEZ TUNNEL
(10,310 ft)
GUMLICK TUNNEL
(10,313 ft)
(10,400 ft)
McQueary Creek
Jones Creek
Darling Creek
Middle Fork Williams Fork River
South Fork Williams Fork River
Steelman Creek
Bobtail Creek
Berthoud Pass
(11,314 ft)
Fall River
West Clear Creek
I-70
Georgetown
Chicago Creek
Clear Creek
GILPIN COUNTY
CLEAR CREEK COUNTY
SUMMIT COUNTY
Source: Denver Water, November 2012
N
W
E
S
0 1 2 3 4 5 10
Miles
Moffat Tunnel Collection System
Major Lake or Reservoir
Major Stream or River
Major Canal or Aqueduct
USGS Gaging Station



Continental Divide

County Boundary

Road

Railroad

Denver Water facilities are annotated in RED.

Aquaducts, canals and tunnels conveying water in the collection system are highlighted in GREEN.

Moffat Collection System Project FEIS

Figure 1-2
Collection System Components

2/24/14

The Wolford Mountain Reservoir, located on Muddy Creek near Kremmling, Colorado, is owned and operated by the Colorado River Water Conservation District. The reservoir has a total storage capacity of 65,985 AF of which Denver Water uses 25,610 AF as a storage pool. Like Williams Fork Reservoir, Denver Water uses water stored in the Wolford Mountain Reservoir as a substitution source for Denver Water's obligation to Green Mountain Reservoir.

1.3.1.4 Non-Potable Recycling Facility

In 2000, Denver Water constructed a non-potable water recycling plant near the Metro Wastewater Reclamation District Plant (Metro Wastewater Treatment Plant [WWTP]) in Denver. The ultimate plant capacity is 45 million gallons per day (mgd), capable of delivering up to 17,500 AF of water per year to non-potable uses in the future. The existing plant capacity is 30 mgd, with about 7,000 AF/yr to non-potable uses. Existing customers of the plant are the Cherokee Power Plant, Washington Park, City Park and Golf Course, Denver Country Club, Park Hill Golf Course, and redevelopment at Stapleton and Lowry. Potential future customers include the Rocky Mountain Arsenal, Denver International Airport, and various parks and industrial users along the distribution system route.

The non-potable recycling facility is supplied in large part by Denver Water's reusable water from the Metro WWTP. A portion of the water delivered to Denver Water's customers is not fully consumed and returns to a stream as effluent from a WWTP or by groundwater return flow as a result of lawn irrigation. Return flows of non-reusable water belong to downstream water right holders and cannot be used a second time by Denver Water. However, return flows of reusable water can be used over and over to extinction (i.e., until it is used up). The main sources of reusable water in Denver Water's Collection System are:

- Blue River water delivered through the Roberts Tunnel
- Fraser River water diverted by the Cabin-Meadow Creek system (the only reusable water associated with the Moffat Collection System)
- Transferred agricultural water rights on the East Slope

The Metro WWTP and the Littleton-Englewood (Bi-City) WWTP are the primary return flow points of Denver Water's reusable water. Denver Water keeps track of reusable return flows and currently reuses portions of these supplies as the source of water for the non-potable recycling plant and for exchanges to upstream facilities.

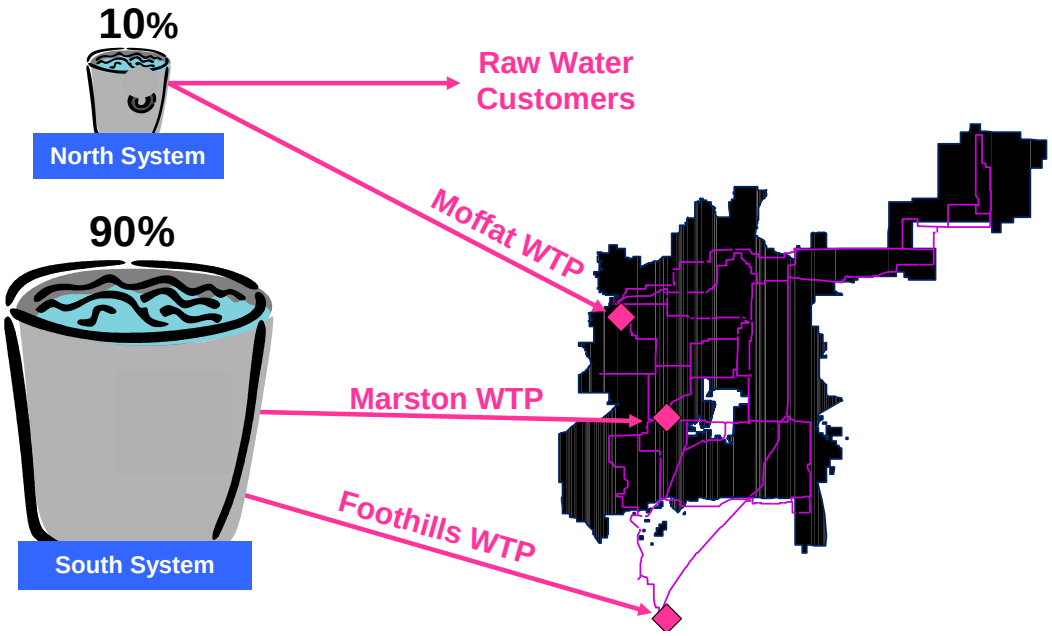
1.3.1.5 Hydropower Generation

There are currently six hydroelectric generating power plants associated with the raw water collection system. These include the Williams Fork Dam, Dillon Dam, East Portal Roberts Tunnel, Strontia Springs Dam, Gross Dam, and headworks of the Foothills WTP.

1.3.1.6 Implications of Denver Water's Raw Water Collection System and Operations to Project Purpose and Need

As discussed above, Denver Water's raw water collection system has two major delivery systems: the North System (Moffat Collection System), which provides raw water to the Moffat WTP, and the South System, which provides raw water to the Foothills and Marston WTPs. Approximately 90% of the available water storage and 80% of available water supply are dependent upon trouble-free operation of the South System, as shown in Figure 1-3. There are no raw water conveyance facilities connecting the two systems.

Figure 1-3
Collection System Imbalance



Note:
WTP = Water Treatment Plant

The imbalance in water supply between the North and South systems results in a substantial vulnerability for Denver Water's raw water customers and diminishes the operational flexibility needed to meet customer demand under a variety of conditions. This vulnerability was demonstrated during the drought year of 2002 when Denver Water would have run out of water to supply the Moffat WTP and its raw water customers had it not implemented emergency measures. These measures included imposing mandatory restrictions, reducing minimum bypass flows on West Slope streams in the Moffat Collection System, shutting off the Moffat WTP during portions of the drought, and pumping treated water from Foothills or Marston WTPs into ditches for delivery and re-treatment by raw water customers. Refer to Section 1.4.4 for details. Improving the imbalance in available water supplies and storage facilities in the North and South systems is a major factor underlying the need for the Moffat Project.

1.3.2 Treated Water System

Denver Water serves treated water to the City and County of Denver and 65 suburban distributors within its Combined Service Area (CSA), which includes more than 300,000 accounts and approximately 1.3 million people. Figure 1-4 shows the CSA and major treated water distribution features. Section 1.3.3 provides more information on Denver Water's customers.

Denver Water's treatment system uses conventional process design consisting of coagulation/sedimentation, filtration, and disinfection processes. The treated water meets or exceeds all the standards set by the State of Colorado and the Federal Safe Drinking Water Act.

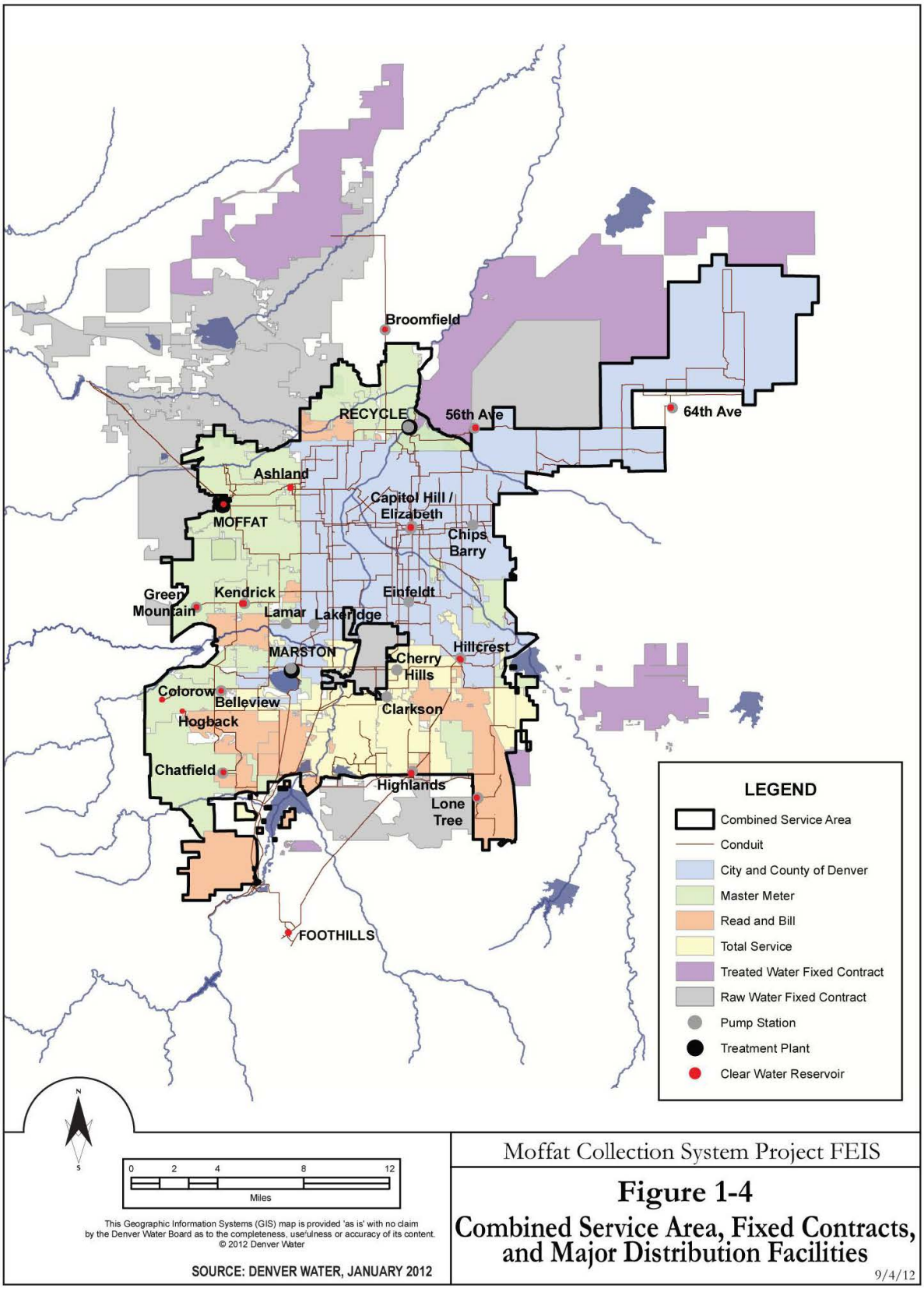
Denver Water's treated water facilities include:

- The Foothills, Marston and Moffat WTPs with a combined capacity of 715 mgd
- 18 pump stations with a pumping capacity of 1,003 mgd
- 30 treated water storage reservoirs in 16 locations totaling 344 million gallons
- 3,000 miles of pipe; 76,500 valves; and about 19,500 hydrants
- The recycled water system consisting of 45 miles and 865 valves

The Foothills and Marston WTPs treat water from the South Platte Collection System and Roberts Tunnel Collection System, while the Moffat WTP treats water from the Moffat Collection System. Unlike the raw water collection systems, the treated water system is connected. During periods of low demand, it is possible for any of the three treatment plants to serve most areas within the CSA. In general, the Foothills WTP is the primary treatment plant used to meet treated water demands, because of its lower cost of operation and ability to provide water to most of the areas Denver Water serves by gravity. The Marston and Moffat WTPs are primarily peaking plants, with greatest use generally during high demand. From the treatment plants, main conduits deliver water either directly into the distribution system or to pump stations and clear water storage reservoirs. The system is designed for dual feed to any area to minimize service interruption and to maintain fire protection capability.

1.3.3 Denver Water Customers

Denver Water provides water to its customers within its CSA and to fixed-amount contracts outside its service area. Denver Water's CSA includes the City and County of Denver, plus the total geographic service areas of all its distributors, defined as those entities that rely solely on Denver Water's potable water for their water supply (Figure 1-4). Within the CSA, Denver Water acts as a public utility, regardless of whether the customers served are located inside or outside of Denver. Total water demand within Denver Water's CSA amounted to about 249,000 AF in 2010, including distribution losses (Denver Water 2011). This represents about a 10% increase since the drought years 2002 and 2003.


Broomfield
RECYCLE
56th Ave
64th Ave
Ashland
Capitol Hill / Elizabeth
MOFFAT
Chips Barry
Green Mountain
Kendrick
Einfeldt
Lamar
Lakeridge
MARSTON
Cherry Hills
Hillcrest
Colorow
Belleview
Hogback
Clarkson
Chatfield
Highlands
Lone Tree
FOOTHILLS
LEGEND
Combined Service Area
Conduit
City and County of Denver
Master Meter
Read and Bill
Total Service
Treated Water Fixed Contract
Raw Water Fixed Contract
Pump Station
Treatment Plant
Clear Water Reservoir
N
S
0 2 4 8 12
Miles
This Geographic Information Systems (GIS) map is provided 'as is' with no claim by the Denver Water Board as to the completeness, usefulness or accuracy of its content.
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SOURCE: DENVER WATER, JANUARY 2012
Moffat Collection System Project FEIS
Figure 1-4
Combined Service Area, Fixed Contracts, and Major Distribution Facilities
9/4/12

Approximately 1.3 million people (1.1 million treated water customers) in the Denver Metropolitan area depend entirely upon Denver Water for their treated municipal, industrial, and commercial water. In addition to treated water Denver Water also provides substantial amounts of recycled water and fixed amount raw water contracts. The IRP (Denver Water 2002a) provides more detail on Denver Water's customer obligations. Customers fall within three major categories:

- **City and County of Denver** – By charter, Denver Water is required to provide an adequate supply of water to the people of the City and County of Denver "for all uses and purposes," through its ultimate buildout. About 52% of the public utility's customer accounts are within the City and County of Denver.
- **Suburban Distributors** – By the Colorado Constitution, Colorado State Statute, and the Denver Charter, Denver Water is obligated to provide water service to certain suburban users outside of the City and County of Denver, but within its CSA. For many of these users, the majority of which are cities or quasi-municipal water districts, Denver Water is the sole source of water. Denver Water's obligation under the distributor contracts is perpetual.
- **Fixed-Amount Contracts** – Denver Water is obligated to provide specified amounts of either potable or non-potable water under approximately 20 fixed-amount contracts. Most of these contracts are with municipal or quasi-municipal entities located outside the CSA. Several of the larger contracts specify delivery locations within the Moffat Collection System. Denver Water's obligation under these fixed-amount contracts is perpetual.

1.4 BASIS FOR PURPOSE AND NEED

The Purpose and Need of the Moffat Project, as stated in Section 1.1, is to address two issues: (1) water supply shortage in the near-term timeframe (timeliness issue), and (2) the need to supply water to the Moffat WTP and raw water customers (location issue).

Sections 1.4.1 through 1.4.3 present Denver Water's demand and supply issues and the quantification of its water supply shortage in the near-term timeframe, while Section 1.4.4 describes the location and timeliness issues in more detail.

1.4.1 Existing and Future Demand

In its IRP, Denver Water analyzed existing and future water supplies and customer demands, together with treated water infrastructure and conservation measures (Denver Water 1997, 2002a). Based on the IRP and a subsequent update of the demand projections, Denver Water segmented its planning horizon into the near-term timeframe (1997 to 2032) and the long-term timeframe (2032 to 2050).

Since the publication of the Draft EIS, and in response to comments, the Corps determined that an update of the water demand projections was warranted. The Corps requested that Denver Water update its water demand projections with the latest economic and demographic information. The Corps evaluated these more recent projections for suitability for the Final EIS, and Denver Water's update and evaluation are found in Appendix A.

Table 1-1 is a brief summary of Denver Water's 2002 (from the IRP), 2010, future near-term (2032), and future long-term (2050) demands and supplies. Figure 1-5 is a graphical depiction of the demand and supply information provided in Table 1-1, indicating that the newly developed supplies would need to be on-line as early as 2022 and that all of the newly developed 18,000 AF would be used by Denver Water customers by 2032.

Table 1-1
Summary of Denver Water's Planning Estimates

Category	2002 IRP	2010	2032	2050
	(AF/yr)			
Demand[1]				
Unrestricted Demand	314,000	330,000	432,700	499,700
Less:				
Historic Conservation Savings 1980 to 2000	(29,000)	(29,000)	(29,000)	(29,000)
Natural Replacement Savings	N/A	(11,800)	(27,700)	(39,000)
Plus:				
1999 Arvada Contract	N/A	N/A	3,000	3,000
Total System Demand	**285,000**	**289,200**	**379,000**	**434,700**
Supply[2]				
System Supply	315,000	315,000	315,000	315,000
Plus:				
System Refinements/Cooperative Actions	N/A	12,500	12,500	12,500
Non-Potable Reuse	N/A	17,500	17,500	17,500
Total System Supply (Nearest 1,000)	**315,000**	**345,000**	**345,000**	**345,000**
Surplus/(Shortfall)[3]	**30,000**	**55,800**	**(34,000)**	**(89,700)**
Plans to Meet Shortfall				
Additional Conservation	N/A	16,000	16,000	16,000
New Water Supply	N/A	N/A	18,000	(73,700)

Source: Modified from Denver Water, 2004a, 2012; Harvey Economics, 2012.

Notes:

[1] Demand terms:

Unrestricted Demand – Customer demand, including fixed contracts, that does not include reductions due to drought restrictions, historical conservation, or natural replacement.

Natural Replacement – Customers replacing outdated, inefficient plumbing fixtures with water-efficient fixtures such as low-flow toilets. Reductions in water use are independent of Denver Water's conservation programs.

Arvada Contract: This is a contingent obligation dependent upon the extent to which Denver Water is able to solve its Moffat Collection System shortage problem. Thus, the 1999 Arvada Contract was not included in the demand calculations during the 2002 IRP update. For more details, refer to the description of Northwest Cooperative Action in Section 5.3.4 of Denver Water's Purpose and Need Document (Denver Water 2004a).

[2] Supply-enhancement measures to be implemented by 2032. These actions are described in more detail in Section 1.4.3. A breakdown of the yield provided from the major components of Denver Water's system is provided in Table 1-3.

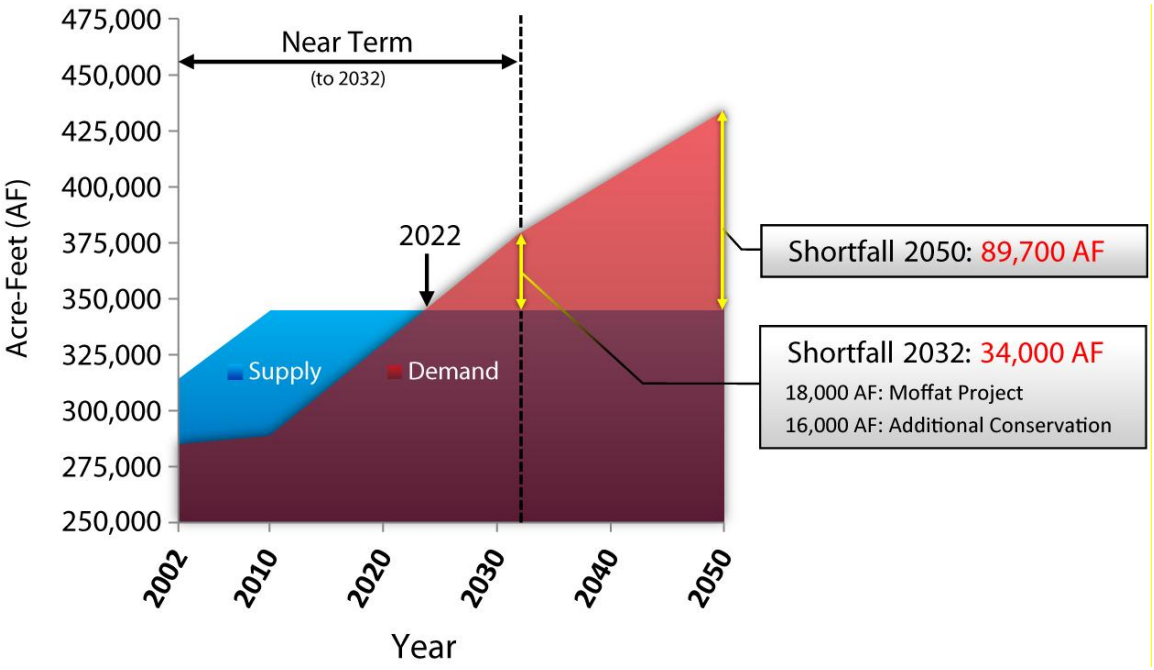
[3] Denver Water's 30,000-AF safety factor is not included in the calculation of the shortfall because it is not considered available for meeting the total system demand each and every year. Rather it is intended to address uncertainties and/or unforeseen events. Refer to Section 1.4.1.5 for details.

AF/yr = acre-feet per year

IRP = Integrated Resources Plan

N/A = not applicable

Figure 1-5
Total Annual Denver Water System Demand Versus Supply



Denver Water calculated its total system demand using the following steps:

1. An existing use and demand forecast was completed for the CSA using a demand-forecast model that predicted demand by customer class for single-family, commercial/industrial/multi-family and governmental/institutional customer classes.
2. The demand forecast reflects the conservation savings that have been achieved since 1980. Without this conservation, the forecasted demand would have been 29,000 AF higher.
3. That demand forecast was reduced by the amount of demand savings that are expected to occur by means of future natural replacement of inefficient plumbing fixtures.
4. Denver Water's existing commitments to deliver treated and raw water outside the CSA and raw water customers within the CSA were added to the demand forecast. Under an Intergovernmental Agreement (IGA) with the City of Arvada, Denver Water agreed to allow Arvada to purchase a portion of increased firm yield that Denver Water is able to achieve with the Moffat Project.

Each of these steps is described in more detail in the following sections.

1.4.1.1 Existing Use and Demand Forecast

Denver Water's demand forecast—developed in both the 1997 and 2002 IRPs—defines how much additional water is needed for build-out of its CSA and when that water will be needed (Denver Water 1997, 2002a). The demand forecast was completed for the CSA using a demand-forecast model that predicted demand by customer class for single-family, commercial/industrial/multi-family and governmental/institutional customer classes. Refer to

the Demand Forecast Appendix to the 2002 IRP (Denver Water 2002a) for a detailed discussion of the demand forecast model. An independent review of Denver Water's demand forecast model was completed for this EIS and concluded that the water demand projections produced from the 2002 IRP offer an acceptable basis for water supply planning purposes (Harvey Economics 2004a). A copy of the Memorandum prepared by Harvey Economics can be found in Appendix A.

Forecasting water demand is primarily a function of two variables: future demographic growth (population, households, income) within the CSA and the varying rates of water usage for those demographic groupings. The usage relationships emerge from detailed analysis of historical water usage patterns.

The demographic projections utilized in the study largely originated from the Denver Regional Council of Governments (DRCOG), an agency made up of local governments in the Denver Metropolitan area. A complete description of DRCOG's approach and the assumptions made surrounding these projections are provided in the Memorandum of Review of Denver Water's IRP (Harvey Economics 2004a) and Memorandum of Review of Denver Water's Demand Projections Update (Harvey Economics 2012). Refer to Appendix A.

These demand projections were updated through 2010. The more recent demographic and water use information for 2010 indicated reduced water demands for that year compared with those projected for that year in the Draft EIS. The lower figures are largely explained by the recession that began after 2008, additional conservation, and hydrological conditions. However, long-term economic and demographic projections from Denver Water and DRCOG indicate that growth prospects for population have not diminished as a result of the current economic cycle and that Denver will likely experience a higher concentration of employment over the long term. That update, and the independent review of that update, can be found in Appendix A as well.

To develop the water demand forecasting model, Denver Water acquired and evaluated historic demographic and socioeconomic geospatial data from 1973 to 1999, including the 1999 Metropolitan-wide demographic forecast of DRCOG. Statistical analyses were conducted on the data to develop the most representative relationships between customer usage and socioeconomic factors. Various regression analyses, analysis of variance, and other statistical methods were utilized to determine predictors of demand. An example of one of these predictors is the household density per acre, which accounts for the coincidence of higher income households situated on larger lots. This statistical analysis was not updated through 2010 for the Final EIS because the 26 years of data relationships is considered sufficient to successfully complete the regression analyses.

The analyses resulted in demand forecasts for single-family, commercial/industrial/ multi-family, and governmental/institutional customer classes. For each class, the model calculates future demand based on the future values of independent variables (such as household income) and their relationship to customer usage. A detailed discussion of the demand forecast model is provided in the Demand Forecast Appendix to the 2002 IRP (Denver Water 2002a).

As shown in Table 1-1, Denver Water's unrestricted demand is forecasted to increase from 314,000 AF in 2002 to 432,700 AF by 2032. Unrestricted demand refers to customer

demand not including reductions due to drought-restrictions, conservation savings, or future replacement of inefficient plumbing fixtures (termed natural replacement).

1.4.1.2 Conservation

Table 1-2 shows conservation measures implemented between 1980 and 2011 to reduce the demand in Denver Water's CSA. Denver Water's customers achieved approximately 29,000 AF/yr of conservation between 1980 and 2000, which is reflected in the total system demand in Table 1-1 and the demand line shown in Figure 1-5. For a detailed description and assessment of the conservation programs, refer to the Conservation Appendix to the 2002 IRP (Denver Water 2002a) and Harvey Economics (2004b). Refer also to Appendix A of this EIS for a copy of the Harvey Economics Memorandum (Harvey Economics 2012) and Denver Water's current conservation plan (Denver Water 2011).

Table 1-2
Summary of Conservation Measures (1980-2011)

Public Outreach and Education	Financial
• Conservation information provided on the Denver Water website • Conservation Hotline • Distribution of a 12-month water conservation calendar • Xeriscape clinics, seminars, and garden tours • School programs • Bus board advertising • Customer bill inserts on water conservation tips and information on xeriscape plants • Radio and TV campaigns • Educational films • Public access to weather station information (e.g., allows large irrigators to adjust water use based on actual evapotranspiration rates) • Conservation outreach to suburban governments and customers • "Use Only What You Need" ad campaign	• Conservation rate structure and a fully metered service area • Rebates for high efficiency and low-flow water fixtures, such as toilets and clothes washing machines • New construction rebates • Rebates for installation of rain sensors and evapotranspiration irrigation controllers on automatic sprinkler systems • Commercial/industrial incentive contracts • Cooling tower retrofit rebates • Public housing toilet retrofits
Monitoring and Audits	**Mandates and Ordinances**

• Personal Water Consultant Measure for the top 1,000 water-using commercial and industrial customers
• Sonic leak detection for mains in water systems
• Residential audits and retrofit programs
• City and State audit programs
• Audit/retrofit program for low income customers
• Rules enforcement
	• "Water Waste"
	  ○ Operates under Chapter 14: Water Conservation rules
	  ○ Rules implemented to prohibit watering between 10:00 a.m. and 6:00 p.m.
	  ○ 5-acre review sets a water use budget for irrigated areas 5 acres or more
	• City ordinance mandates sub-metering for new multi-family buildings
	• City ordinance requiring rain sensors for new irrigation systems
	• Car Wash Recertification
	• Soil Amendment Program

Source: Denver Water, 2006a, 2011.

The effectiveness of Denver Water's demand management and drought restriction efforts at least partially explain the marked decline in average daily consumption per capita expressed as gallon per capita per day (gpcd). By comparison, consumption averaged 211 gpcd between 1994 and 2001, and then, with demand management and restrictions due to drought, dropped 21% to 166 gpcd in 2003. In 2009, gallon per capita per day dropped further to less than 150, although that year was unusually wet during summer months, reducing outdoor irrigation substantially.

1.4.1.3 Natural Replacement

Between 2002 and 2032, an additional annual savings was factored into the demand forecast for the replacement of inefficient plumbing fixtures by customers. This natural replacement savings is expected to reach almost 28,000 AF/yr by 2032 as older plumbing fixtures are replaced. As part of the Corps' review of Denver Water's demand projections, it was determined that this estimate of natural replacement savings could be overly aggressive (Harvey Economics 2004b). Refer to Appendix A for a copy of the Memorandum. A projected savings of approximately 23,000 AF by 2032 was calculated, which is less than Denver Water's forecast. Therefore Denver Water's 2032 demand projections may underestimate actual demands.

1.4.1.4 Intergovernmental Agreement with Arvada

Denver Water has been supplying a portion of the City of Arvada's water since 1965. In 1999, Denver Water entered into an IGA with the City of Arvada. Under the IGA, Arvada assisted in the purchase of property for a future reservoir that was located within Arvada's jurisdiction. Arvada also agreed that the proper land use for the property was as a reservoir site. In exchange for the land for a potential reservoir site (Leyden Gulch), Denver Water's existing commitment to provide water to Arvada may be increased, contingent upon the construction of new facilities or the enlargement of existing facilities in its Moffat Collection System. Denver Water agreed to allow Arvada to purchase a percentage of increased firm yield that Denver Water was able to achieve in the Moffat Collection System, up to a maximum to Arvada of 3,000 AF/yr. Therefore, if Denver Water does not build Leyden Gulch Reservoir they are still obligated to allow Arvada to purchase a percentage of increased firm yield in the Moffat Collection System up to a maximum of 3,000 AF/yr. This additional 3,000 AF/yr is reflected in Denver Water's demand forecasts through 2032 and is reflected in the total system demand in Table 1-1 and the demand curve shown in Figure 1-5.

1.4.1.5 Strategic Water Reserve

Denver Water maintains a Strategic Water Reserve of 30,000 AF/yr of firm yield to account for uncertainties in planning and forecasting and in operation of water supply infrastructure (Strategic Water Reserve was previously termed "safety factor"). This 30,000 AF is not included in the total system supply because it is not considered available for meeting the total system demand under normal operating conditions; rather it is intended to be reserved for uncertainties and/or unforeseen events including, but not limited to:

- Reduction of Denver Water's existing supplies through additional minimum stream flow requirements for endangered species, future changes in water rights, agreements, etc.
- Future changes in hydrology/global warming
- A drought that would be longer or more severe than that contemplated in Denver Water's supply modeling
- Catastrophic losses of system facilities
- Delays in the permitting or construction of future additions to the system
- Faster or larger future demand increases than forecasted in the 2002 IRP

A Strategic Water Reserve provides a level of insulation from demand exceeding supply, if unforeseen events rapidly diminish supplies or inflate demand. Reviews of other water utilities in the nation show that it is a reasonable and prudent practice for a utility the size of Denver Water to maintain a water supply reserve of 8 to 12% of installed supply. A Strategic Water Reserve of 30,000 AF/yr of firm yield, amounting to less than 10% of current supply, was independently reviewed and considered reasonable, especially considering the geographic diversity of Denver Water's system and its size and importance to the Denver Metropolitan area (Harvey Economics 2004b).

1.4.1.6 Demand Summary

Denver Water quantified demands using demand-forecast modeling. Adjustments were made to account for conservation, natural replacement, and the 1999 IGA with Arvada. As shown in Table 1-1 and Figure 1-5, Denver Water's total average annual system demand is forecasted to increase from 285,000 AF in 2002 to 379,000 AF/yr in 2032 – an increase of 94,000 AF/yr. As Figure 1-5 demonstrates, absent any additions to Denver Water's water supply system, demand is predicted to exceed available supply as early as 2022, and by 2032 there could be an anticipated annual shortfall of more than 34,000 AF/yr of water supply. The Platte and Colorado Simulation Model (PACSM) of Denver Water's system and the associated timing and amount of shortfall is based on meeting an unrestricted demand. Modeling water supply and annual firm yield during a drought on the basis of unrestricted demand purposefully excludes consideration of drought response plans for several reasons. Drought responses are primarily intended to respond to droughts of unknown duration and severity, unexpected emergencies, and infrastructure failure. Unlike the Strategic Water Reserve, which is a supply-side solution, drought response is a demand-side device designed to quickly bring demand down in response to reduced supply. Drought response is temporary in nature and inherently uncertain, driven by immediate conditions. Modeling water supply and firm yield assumes a perfectly operating system over a long period of time. This is a widely accepted approach for evaluating a water utility's ability to meet needs under varying hydrologic conditions, while preserving the utility's prerogative to deploy drought response as circumstances require.

1.4.2 Yield of Denver Water's System

The capability of Denver Water's supply system is expressed as the "firm yield" of water that the system can produce on an average annual basis. Firm yield is a measure of a system's ability to reliably supply water to meet demand during drought periods, and is dependent on many factors, including the amount and timing of supplies and demands, reservoir operations, and physical and legal constraints. Although firm yield is controlled by drought periods, it is expressed as the average annual supply available to meet demand during a representative hydrologic study period (which includes average, wet, and dry years). Therefore, the firm yield equals the maximum average annual demand that can be met by Denver Water's system without shortages through the study period. While the firm yield is reported as an average for the study period, the actual modeled water demand and supply varies from day-to-day, month-to-month, and year-to-year. For example, total annual water demand is greater in a hot, dry year than in a cool, wet year. Variations in water demand are largely attributable to outdoor uses of water, most notably lawn irrigation. These variations in water vary from year-to-year based on weather in the Denver Metropolitan area and are taken into consideration when determining the annual yield of Denver Water's Collection System. Modeling conducted using PACSM assumes Denver Water's demand is unrestricted as discussed in Section 1.4.1.6.

To estimate firm yield, Denver Water used PACSM to simulate the operation of water systems facilities over the historical period from 1947 to 1991. PACSM is a system of integrated computer programs and data used to simulate stream flows, reservoir operations and water supply in the South Platte and Colorado river basins. The Corps evaluated PACSM for use in modeling hydrology for this EIS, and found it satisfactory (Boyle 2003b, 2004). As a component of the Upper Colorado River Study (UPCO), an additional independent review of PACSM was conducted. That review concluded that the model adequately simulates the hydrology, operation of major water rights and the operations of major water storage and diversion projects within the Colorado River Basin, to address long-range water supply planning for numerous West Slope entities in Grand and Summit counties (UPCO PACSM Review Committee 1999). The review of PACSM that was conducted for UPCO was also evaluated during the review of PACSM for this EIS.

The following discussion outlines the evaluation used during the 1997 IRP to quantify Denver Water's available supply of 315,000 AF/yr of firm yield. The discussion also addresses the evaluation conducted as part of the 2002 IRP update which estimates a firm yield of 345,000 AF/yr by 2022 with continued implementation of the components of Denver Water's Near-Term Strategy. Refer to Section 1.4.3 for details on the Near-Term Strategy. A breakdown of the yield from the major components of Denver Water's system is provided in Table 1-3.

Table 1-3
Yield of Denver Water's System

Source	Supply (AF/yr)	Percentage
Roberts Tunnel Collection System[1]	93,000	27%
Moffat Tunnel Collection System[2]	64,000	18%
South Platte Collection System[3]	141,000	41%
Exchange and Reuse[4]	47,000	14%
TOTAL	**345,000**	**100%**

Source: Denver Water, 2009a.

Notes:

[1] Net of 5% transit loss imposed on diversions to Strontia Springs Reservoir.

[2] Amount sent directly to demand, not total importation. Net of evaporation and transit losses.

[3] From South Platte River direct and storage rights. Includes South Boulder Creek rights, Bear Creek rights, and South Park rights.

[4] Calculated as the portion of demand not met by Roberts Tunnel, Moffat Tunnel, or South Platte Collection System rights. Net of evaporation and transit losses. Includes reusable water exchanged from Metro WWTP, Bi-City WWTP, and Denver Water exchange gravel pits. Includes reusable supply used to augment miscellaneous raw water demands. Includes reusable supply used to augment non-potable recycling project demands. Includes junior consumptive use rights for downstream reuse gravel pits.

AF/yr = acre-feet per year
Bi-City = Littleton-Englewood
WWTP = Wastewater Treatment Plant

1.4.2.1 PACSM Overview

The study period used in PACSM extends 45 years from 1947 through 1991 and includes a variety of hydrologic conditions with dry years, wet years, and average precipitation years. The period is representative of the long-term conditions for the river basins of concern (Colorado and South Platte river basins) and includes Denver Water's critical drought period of 1953 through 1957. The critical drought period is the time span from the last time the storage reservoirs are full to the time all reservoir water is completely depleted and the reservoirs begin to refill.

Determination of firm yield was simulated using PACSM. Denver Water's firm yield was determined to be 315,000 AF/yr as of 1996 (not including the 30,000-AF Strategic Water Reserve). At this level of demand, PACSM shows that Denver Water's reservoirs were essentially empty sometime in April 1957 and then began to refill, all without causing any shortfall in meeting demand. As part of the 2002 IRP, Denver Water used PACSM to show that its enhanced existing system could produce 345,000 AF/yr of firm yield—30,000 AF/yr more than the collection system could produce in 1996 based on implementation of the non-potable recycling project, system refinements, and cooperative projects that Denver Water assumes will be fully implemented before 2032, as described in Section 1.4.3. Modeling conducted using PACSM assumes Denver Water's demand is unrestricted as discussed in Section 1.4.1.6.

1.4.3 Denver Water's Near-Term Strategy (Present to 2032)

As shown in Figure 1-5, based on the PACSM results, Denver Water predicts that as early as 2022 its unrestricted demand could exceed current supply and, without the addition of new firm yield, an annual water supply shortage could occur. To resolve this shortfall, five near-term strategies are in the process of being implemented for potentially producing new firm yield and reducing demand: (1) conservation, (2) non-potable recycling, (3) system refinements, (4) cooperative projects, and (5) new supply projects such as the Moffat Project being considered in this EIS. These strategies are in various stages of implementation. With this multiple Near-Term Strategy, Denver Water is projecting to have sufficient supplies until 2032.

The Corps independently reviewed Denver Water's Near-Term Strategy and concluded that the development of 18,000 AF/yr of new firm yield is the only action to be analyzed in the EIS. The following information about Denver Water's strategy to provide an adequate, near-term supply is summarized to provide background and context to understanding the Purpose and Need for the Moffat Project.

Each of the components of the Denver Water's Near-Term Strategy is discussed below.

1.4.3.1 Conservation

The 2002 IRP discusses both the various water conservation programs currently in place as well as strategies that may be employed in the future. Denver Water plans to reduce its demand by 16,000 AF/yr by 2032 with conservation measures. These forecasted savings for implementing conservation measures do not include savings associated with mandatory water restrictions imposed during droughts since these are meant as temporary measures to save water only during a drought. Conservation measures are designed to achieve long-term sustainable reductions in water use.

A considerable degree of uncertainty was assumed for these projections. Although the new programs and adjustments are more aggressive than previous conservation programs, there is no compelling analyses or basis to be confident that these savings will occur. Only monitoring and program adjustment can help assure such savings will be achieved (Harvey Economics 2004a).

1.4.3.2 Non-Potable Recycling

Denver Water has implemented a non-potable water recycling project that, when complete, will produce 17,500 AF/yr of water to meet projected irrigation and process water demands. The non-potable recycling project came on-line in 2004 and supplied approximately 7,000 AF that year.

1.4.3.3 System Refinements

Examples of system refinements are lining of ditches, transferring Denver Water's existing agricultural water rights to municipal use, and capturing required bypass flows at downstream facilities. In the 2002 IRP, Denver Water increased the potential yield from system refinements to 12,500 AF/yr. Table 1-4 summarizes types of system refinement projects that are completed or are near completion by Denver Water. The High Line Canal Efficiency project provides 3,000 AF of yield to Denver Water's system as a result of

reducing deliveries along the lower third of the canal. By providing water to users from the lower third of the canal in another manner, Denver Water is able to reduce conveyance losses along the Canal by an estimated 3,000 AF/yr. With less water diverted by the High Line Canal, Denver Water and others can at times divert more water under other existing water rights including exchange rights.

The Strontia Fish Flow Recovery project provides approximately 3,000 AF of yield to Denver Water by recovering water that is released from Strontia Springs Reservoir to maintain fish flows in Waterton Canyon. In 2006, Denver Water completed a permanent pump facility above Chatfield Reservoir at the diversion site of the Old Last Chance Ditch to recover fish flow releases from Strontia Springs Reservoir. The new diversion facility is sometimes referred to as the Kassler Pump Station Diversion. Water released at Strontia Springs Reservoir can be diverted at the Kassler Pump Station Diversion and then pumped to Conduit 20 for delivery to Marston Reservoir and the Marston WTP. This facility could potentially provide most of the 3,000 AF of yield. Denver Water plans on building an additional pump station at the outlet works of Chatfield Reservoir, which would enable Denver Water to recover fish flow releases that are not diverted at the Kassler Pump Station.

The full 12,500 AF/yr will be available within the next 7 to 10 years and, as shown in Table 1-1, has been accounted for in calculating the total system supply in 2032 of 345,000 AF.

Table 1-4
Representative System Refinement Projects

Project	Firm Annual Yield (AF/yr)
Gravel Pit Storage	5,000
High Line Canal Efficiency	3,000
Strontia Fish Flow Recovery	3,000
Lawn Irrigation Return Flows	500
Others	1,000
TOTAL	**12,500**

Source: Denver Water, 2004a (and re-verified in 2012 by the Denver Water Planning Department).
Note:
AF/yr = acre-feet per year

1.4.3.4 Cooperative Projects

Denver Water's Near-Term Strategy to reduce its shortfall includes a goal of 10,000 AF/yr realized through cooperative projects with local water providers. To facilitate this cooperation, Denver Water established four regional water provider groups outside the CSA, which include Northeast, Northwest, South Metro, and the City of Aurora. In each group, an evaluation was conducted of supply, demand, operations and potential system integration that might result in new firm yield for Denver Water and the cooperating entities. Denver Water completed evaluations of cooperative actions in three of the four areas (Northeast, Northwest, and South Metro) to share its existing and future resources. The 1999 IGA with the City of Arvada is one example.

However, Denver Water determined from these studies that only one cooperative action – the 440-AF Consolidated Mutual project consisting of the construction of Welton Reservoir – would develop new firm yield for Denver Water and its customers. Denver Water concluded that the remaining cooperative actions would not increase Denver Water's yield, despite other merits they might have to others.

Denver Water continues to explore cooperative actions with the City of Aurora as a part of its Long-Term Strategy (post 2032). Only the 440 AF/yr of the 10,000 AF/yr of new firm yield identified in the IRP as a goal from cooperative actions has proven possible in the near term. A summary of the evaluation of cooperative actions with each regional group is provided in the 2002 IRP and Denver Water's Purpose and Need Statement (Denver Water 2002a, 2004a).

1.4.3.5 Summary of Near-Term Strategy

As part of the 2002 IRP, Denver Water used PACSM to project that its existing system could produce 345,000 AF/yr of firm yield with the adoption of the Near-Term Strategies described above. This firm yield includes the potential new firm yield from implementation of the non-potable recycling project, system refinements, and cooperative projects, which are expected to be fully implemented before 2032 as part of Denver Water's Near-Term Strategy. Denver Water's total system demand is predicted to be 379,000 AF by 2032. As shown in Figure 1-5, Denver Water estimates that, by 2032, it could have an annual water supply shortage of about 34,000 AF based on meeting its unrestricted demand (379,000 AF minus 345,000 AF). Denver Water's strategy for addressing this shortfall is to provide 16,000 AF/yr from conservation savings. The remainder of the shortfall will be addressed through the Proposed Action to develop 18,000 AF/yr of new firm yield for delivery to the Moffat WTP and to Denver Water's raw water customers that rely on the Moffat Collection System.

In order to provide an additional 18,000 AF/yr of firm yield, Gross Reservoir would need to be enlarged by 72,000 AF to a total capacity of 113,811 AF (not including the Environmental Pool). Denver Water determined the 72,000 AF using PACSM by increasing the simulated storage at Gross Reservoir until it was large enough to meet an additional annual demand of 18,000 AF without a shortage during the 4-year critical drought period (1953-1957). In other words, based on hydrologic modeling, Denver Water needs 4 years' worth of supply in storage as a "savings account" to ensure it can provide water each year (i.e., firm yield) through a drought to its customers. Thus, the 4:1 storage to firm yield ratio of 72,000 AF to 18,000 AF.

1.4.4 Timeliness and Location of New Yield

The timing for new firm yield and the requirement that it be located in the Moffat Collection System are driven by the following issues:

- Unreliable water supply for the Moffat WTP and Moffat Collection System raw water customers
- System-wide vulnerability issues
- Limited operational flexibility of the treated water system

While model results indicate the water supply shortfall is predicted to begin as early as 2022, and increase to 34,000 AF by 2032, there is an imminent need for new firm yield. This need for the new water supply and requirement that the new water supply be available to the Moffat WTP are driven by an imbalance in supplies in Denver Water's raw water collection systems, which in turn creates a system-wide vulnerability issue, and limits the operational flexibility of the treated water system. Each of these issues is discussed in relation to the current need for new water supply and the requirement that it be provided to the Moffat WTP.

1.4.4.1 Raw Water Availability to the Moffat Treatment Plant (System Reliability)

Because of an inadequate supply in the Moffat Collection System demonstrated through modeling and during actual operations in 2002, Denver Water's raw water customers and its Moffat WTP currently face the potential to run out of water in a single dry year. Based upon PACSM with today's demand on Denver Water's Collection System, there were four single dry years in the 45-year study period when the Moffat Collection System would have run out of water. Additionally, there are other years when the Moffat Collection System would have been close to running out of water.

Actual Moffat Collection System operations in 2002 demonstrate the lack of a reliable water supply. Denver Water would have run out of water if it had not implemented emergency measures to preserve and increase water in the Moffat Collection System, including:

- Mandatory restrictions
- Strict surcharges for water use
- Reducing minimum bypass flows on western slope streams
- Shutting off the Moffat WTP during portions of the drought
- Constructing infrastructure and pumping treated water from the South System into inefficient ditches for delivery and re-treatment by raw water customers

These types of emergency, inefficient and expensive strategies do not provide an adequate permanent solution for the lack of water supply available to the Moffat WTP. Further, one of three treatment plants was unavailable during peak demand season when a minimum of two plants were needed to meet demands. If an unplanned outage had occurred at one of the remaining operational plants, service to customers would have been interrupted. The imminent need to provide additional supply to the Moffat WTP is also driven by the following criteria.

- In order to ensure that customer demand can be met at a time when the Foothills and/or Marston WTPs are shut down for regular maintenance or emergency conditions, the Moffat WTP needs to be operated at a minimum "idle" rate of 30 mgd between mid-October and April. The reason for this rate is based on several factors. If the plant is completely shut down, it takes too long to prime the chemical feeds and prepare the filters before the plant could operate and meet customer demand. A minimum idle is also important for winter months during low customer demand. In addition, if the idle rate is too low, upsets in water quality could occur if the plant rate is increased too rapidly.

- The Moffat WTP needs to be capable of meeting full indoor demand in the CSA for several weeks in the winter of a dry year to account for routine and unexpected outages. This plant must be capable of operating at full capacity during this period.
- To ensure efficient use of water system infrastructure and proper system flexibility, supply needs to be more evenly positioned and accessible to each treatment plant. In the spring of 2003, the amount of usable water remaining in Denver Water's major reservoirs totaled about 227,000 AF of which only 12,000 AF (about 5%) were available to the Moffat WTP (whereas the Moffat WTP accounts for about 25% of Denver Water total treatment capacity).

The lack of a reliable water supply accessible to the Moffat WTP in a single dry year illustrates both the need for new firm yield and a way to deliver it to the Moffat WTP. Adding 18,000 AF/yr of new firm yield to the Moffat WTP will improve the reliability of the Moffat Collection System, as well as the entire collection system.

1.4.4.2 System Vulnerability

Denver Water's entire collection system is currently vulnerable to natural and manmade disasters and system failures. Approximately 90% of overall available reservoir storage and 80% of available water supplies rely on the unimpeded operation of Denver's South System, particularly Strontia Springs Reservoir. Loss of operation of any portion of the South System could require more water from the Moffat Collection System to meet customer's water demands. This would exacerbate the water supply reliability problem discussed above and could cause an interruption of service to customers.

The critical components in the South Collection System are:

- Roberts Tunnel, Dillon Reservoir, Eleven Mile Reservoir, Cheesman Reservoir, Antero Reservoir, and Strontia Springs Reservoir
- Foothills and Marston WTPs
- Conduits 26 and 20, the raw water conduits transporting water to Foothills and Marston WTPs, respectively.

Examples of natural disasters that could jeopardize South System water supply are forest fires, landslides, earthquakes, and floods. Manmade disasters include terrorism and chemical spills. Potential impacts on Denver Water's ability to meet customer demands as a result of natural and manmade disasters are described in more detail in the 2002 IRP and Denver Water's Purpose and Need Statement (Denver Water 2002a, 2004a). New water supply to the Moffat WTP would reduce the current system's vulnerability to disasters and failures and allow Denver Water to adjust to South System outages by shifting more customer water demand to the Moffat WTP.

1.4.4.3 Operational Flexibility

In addition to scheduled maintenance outages, Denver Water's Collection System also experiences unplanned outages due to mechanical failures and power failures. Reasonably, it is anticipated that outages will occur more frequently as Denver Water's infrastructure continues to age. An outage in the South System generally requires Denver Water to shift

more of the water supply function to the Moffat Collection System, which compromises the supply available to the Moffat WTP. Although Denver Water has three treatment plants and two main collection systems, the Moffat WTP does not currently have access to sufficient supplies to provide the range of operational flexibility needed to meet customer demand. Providing additional supplies to the Moffat WTP would provide more operational flexibility and allow for the necessary distribution of water throughout the system. Additional information about planned and unplanned collection system outages is provided in the 2002 IRP and Purpose and Need Statement (Denver Water 2002a, 2004a).

1.4.4.4 Summary

The Moffat Project's purpose is to resolve Denver Water's need for new firm yield, lack of a reliable water supply to the Moffat WTP, vulnerability in its system, and lack of the flexibility in its treated water system. It is Denver Water's opinion that additional water supply and the associated distribution facilities would help meet these needs.

1.5 REQUIRED PERMITS AND APPROVALS

Construction and operation of any of the proposed alternatives under consideration for the Moffat Project, including the preferred alternative to enlarge Gross Reservoir by 77,000 AF (with the Environmental Pool for mitigation), would require a Section 404 Permit from the Corps. As part of the permit process, and because the Corps is neither an opponent nor a proponent of Denver Water's proposal, a systematic and unbiased evaluation of the practicable alternatives is required under the Corps' Section 404(b)(1) Guidelines (40 CFR 230) and Public Interest Review (33 CFR 320).

After issuance of the Final EIS, the Corps must wait at least 30 days before issuing a Record of Decision (ROD) as specified in 40 CFR 1506.10 and 33 CFR 325 Appendix B Section 18. The Corps' ROD will include information prescribed at 40 CFR 1505.2 as well as a determination relative to its Public Interest Review (33 CFR 320) and Section 404(b)(1) Guidelines compliance determination (40 CFR 230). The Corps may decide to: (1) issue the permit for the Applicant's preferred alternative, (2) issue the permit for the Applicant's preferred alternative with modifications or conditions, or (3) deny the permit (33 CFR 325 Appendix B Section [9]b[5] and 40 CFR 230). The Corps may add special conditions to the permit to satisfy public interest requirements provided those conditions are directly related to the impacts, are appropriate to the scope and degree of those impacts, and are reasonably enforceable (33 CFR 325.4[a]). Conditions may also be added to address the requirements of the Section 404(b)(1) Guidelines (40 CFR 230.12[a][2]).

In addition, other Federal, State, and local permits and approvals will be required to implement the Moffat Project. This EIS provides information for the other regulatory agencies having jurisdictional responsibility for lands and resources affected by the Moffat Project. Table 1-5 lists the permits and approvals considered necessary for initiation and completion of the Proposed Action.

Table 1-5
Environmental Permits and Approvals Likely Required to Construct and Operate the Moffat Collection System Project

Permit/Approval	Purpose	Applicable Project Component
FEDERAL		
U.S. Army Corps of Engineers (Corps) Permit to Discharge Dredged or Fill Material (Section 404 Permit)	Authorizes placement of fill or dredged material in waters of the United States (U.S.) including adjacent wetlands.	All surface-disturbing activities affecting waters of the U.S., including wetlands, such as construction of a dam, reservoir, diversion structure, roads and pipeline crossings.
U.S. Forest Service (USFS) Federal Land Policy and Management Act of 1976	Authorizes occupancy, use, rights, or privileges of USFS land. The authorization is granted for a specific use of the land for a specific period of time.	Additional USFS lands needed for Project facilities at Gross Reservoir.
Federal Power Act (Section 4e) Authority	Authorizes the USFS to impose conditions within a Federal Energy Regulatory Commission (FERC) license.	Conditions may be imposed by the USFS to address new Project modifications within the FERC project boundary at Gross Reservoir.
U.S. Fish and Wildlife Service Endangered Species Act (Section 7) Compliance	Protects threatened and endangered species.	Any activity potentially affecting listed or proposed threatened or endangered species, such as the Preble's meadow jumping mouse and greenback cutthroat trout.
Migratory Bird Treaty Act	Protects migratory birds.	All surface-disturbing activities affecting migratory birds, such as burrowing owls and raptors.
Fish and Wildlife Coordination Act	Compliance with the Corps' obligations under the Fish and Wildlife Coordination Act and State Law 37-60-122.2.	All surface-disturbing activities affecting fish and wildlife in the Project area.
U.S. Department of the Interior – Advisory Council on Historic Preservation Cultural Resource Compliance (Section 106 of the National Historic Preservation Act of 1966, as amended [NHPA])	Protects cultural and historic resources; coordinated with the Colorado State Historic Preservation Officer (SHPO).	All ground-disturbing activities.
Federal Energy Regulatory Commission (FERC) Hydropower License Amendment	Authorizes construction at Gross Dam and an increase in water levels in Gross Reservoir, which are features of the Gross Reservoir Hydroelectric Project (FERC Project No. 2035).	All properties or facilities related to the FERC hydropower license.

Table 1-5 (continued)
Environmental Permits and Approvals Likely Required to Construct and Operate the Moffat Collection System Project

Permit/Approval	Purpose	Applicable Project Component
STATE OF COLORADO		
Colorado State Engineer's Office, Division of Water Resources Permit to Construct Facility (Dam) Reservoir Storage Permit Dam Safety Permit	Authorizes dam and reservoir construction and reviews dam safety.	Dam and reservoir construction and operation.
Colorado Department of Public Health and Environment, Air Pollution Control Division Land Development Permit (Fugitive Dust Control Plan)	Protects air quality from dust and airborne particulates resulting from construction activities over 25 acres in size or 6 months in duration.	All ground-disturbing construction activities.
Air Pollutant Emissions Notice (APEN)	The APEN reporting threshold for criteria pollutant, particulate matter less than 10 microns in diameter (PM_{10}) is 2 tons per year (uncontrolled rate) for emissions sources in attainment areas (the Moffat Project is an in attainment area). If the Moffat Project were to emit 5 (or more) tons per year of PM_{10} (uncontrolled rate), then an air quality permit would be needed.	Concrete batch plant.
Colorado Department of Public Health and Environment, Water Quality Control Division General Permit for Stormwater Discharges Associated with Construction Activity	Controls the discharge of stormwater pollutants associated with construction activities.	All ground-disturbing construction activities disturbing more than 1 acre.
Section 401 Water Quality Certification	Ensures that activities authorized under Section 404 meet State water quality standards and do not degrade water quality.	All activities subject to the Section 404 Permit from the Corps.
Construction Dewatering Permit	Ensures that dewatering of groundwater from a construction site does not impair the receiving waters.	Dewatering during excavation and placement of fill for the dam.
Office of Archaeology and Historic Preservation, Colorado State Historic Preservation Officer (SHPO)	Determines significance of cultural resources potentially affected by ground disturbing activities.	All ground-disturbing activities.
Colorado Water Court System Water Rights	Legal appropriation of water in the State of Colorado.	Surface water and/or groundwater used by the Project.

Table 1-5 (continued)
Environmental Permits and Approvals Likely Required to Construct and Operate the Moffat Collection System Project

Permit/Approval	Purpose	Applicable Project Component
Colorado Water Conservation Board, Wildlife Commission, and Colorado Parks and Wildlife Colorado Revised Statutes (CRS) 37-60-122.2	Develops the official state position on mitigation of impacts to fish and wildlife resources.	All activities potentially affecting fish and wildlife resources.
COUNTY PERMITS		
Engineering Department Grading Permit	Authorizes construction activities.	All ground-disturbing facilities.
Floodplain Development Permit	Authorizes construction within a floodplain.	Diversion structure.
Right-of-Way (ROW) Use Permit	Authorizes construction within ROWs.	Pipelines within ROWs.
Planning Department Use by Special Review	Addresses probable effects on county services and resources.	All Project facilities proposed to be modified.
Building Department Building Cut Permit	Authorizes construction of all Project facilities.	All Project facilities.

1.6 AGENCY AND PUBLIC SCOPING ISSUES

In accordance with the NEPA (40 CFR 1501.7), the Corps initiated the scoping process to provide for an early and open process to gather information from the public and interested agencies on the issues and alternatives to be evaluated in the EIS. During the public scoping period, the Corps held an agency scoping meeting on October 7, 2003, and three public scoping meetings – in Boulder on October 7, 2004, in Denver on October 8, 2004, and in Silver Creek on October 9, 2004. The NEPA scoping process, original scoping letters, and specific comments gathered by the Corps during the process are detailed in the Scoping Summary, Moffat Collection System Project (Corps 2003).

The most frequent issues and concerns raised by the commentors related to potential effects to surface water resources, water supplies, and water rights. Forty-six percent of comments received were provided by entities and individuals on the West Slope. The most frequent issues and concerns found to be repeated during the scoping process included:

- Effects of proposed diversions by Denver Water from the Fraser River on water supply needs in that basin for municipal water demands and environmental requirements
- Effects of the proposed diversion on the economy of the Fraser River Basin, in particular the water-related, recreation-based economy of Grand County, and the potential lost opportunities for future growth in Grand County
- Effects of Denver Water reducing or eliminating bypass flows in the Fraser River Basin pursuant to its USFS agreements

Other issues/concerns that generated the most comments were related to the following topics:

- Additional alternatives to be considered, in particular conservation, reuse, and other non-structural alternatives
- Effects of additional diversions and water storage on stream flow, fish, wildlife, and vegetation on both sides of the Continental Divide

The following list includes topics raised by commentors and specific issues raised during the NEPA scoping process.

- **Project Purpose and Need** – Including discussion of definition of firm yield and reliability, flexibility, and vulnerability problems.
- **Potential Alternatives** – Including discussion of Gross Reservoir expansion, a new reservoir at Leyden Gulch, potable recycling facility, West Slope alternatives, East Slope alternatives, conservation/non-structural alternatives, groundwater alternatives, and combinations of alternatives and alternatives proposed in other projects.
- **Surface Water Resources** – Including discussion of: Fraser River/West Slope and South Boulder Creek issues, hydrologic effects on other streams, sedimentation, water quality (chemical, physical, and biological) and mitigation measures.
- **Groundwater Resources** – Including discussion of effects of depletions to the Fraser River, Elk Creek, and St. Louis Creek on groundwater recharge.
- **Water Rights and Water Use** – Including discussion of effects on water users on the West Slope and in other regions.
- **Air Quality and Meteorology** – Including discussion of alternative implementation and contribution to air pollution.
- **Soils** – Including discussion of erosion and sedimentation, and potential historic contamination.
- **Geology** – Including discussion of effects of earthquake activity on proposed reservoir sites, and impacts to unique geologic features.
- **Vegetation** – Including discussion of effects of depletions to waterways on riparian and aquatic habitat and effect of inundating previously upland areas.
- **Wetlands** – Including discussion of effects of depletions to water quality functions of wetlands, effects of filling existing wetlands, and mitigation measures.
- **Wildlife and Fisheries** – Including discussion of effects of depletions and water quality changes to fisheries, other wildlife, and their habitat, the future effects on fisheries and threatened and endangered species; effects on whirling disease, effects on potable recycling, and mitigation measures.
- **Cultural and Paleontological Resources** – Including discussion of inundation of archaeological and cultural resources, and effects on existing cultural and paleontological resources.

- **Land Use** – Including discussion of effects of land development, potential for induced growth and land use compatibility.
- **Recreation** – Including discussion of effects on existing and planned water-related recreation; effects on open space, hiking trails and other upland recreational opportunities; effects on the ski industry, and effects on existing recreation planning documents.
- **Visual Resources/Aesthetics** – Including discussion of effects on scenic characteristics, landscape, and attractions in the alternative Project areas.
- **Socioeconomics** – Including discussion of effects on the local economy, tourist-based, and recreational economy; effects on property values; effects on the cost of water, and effects of induced growth.
- **Environmental Justice** – Including discussion of conducting a complete and impartial evaluation of all populations.
- **Transportation** – Including discussion of effects of construction and maintenance truck traffic; effects on local traffic patterns and other construction projects; changes to access, and consideration of transportation planning.
- **Hazardous Materials** – Including discussion of potential for spills and contaminated soils and/or water sources.
- **Noise** – Including discussion of effects of alternatives development related to increased noise pollution.
- **Cumulative Impacts** – Including discussion of consideration of other ongoing projects in the region; consistency in analysis with these other projects including evaluation of impacts to physical, biological, and human resources.

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